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ORANGE RUSTS OF RUBUS

J. C. ARTHUR

(WITH ONE FIGURE)

Much interest has been taken recently in the short cycle rusts, especially since the startling discovery by KUNKEL,[1] 4 years ago, that a rust, indistinguishable from the aecia of *Gymnoconia interstitialis*, would produce promycelia. The year following, FROMME[2] and the writer demonstrated the telial nature of *Aecidium tuberculatum* Ellis and Kellerm., previously treated as a probable heteroecious rust. KUNKEL'S discovery stimulated researches by OLIVE and WHETZEL[3] upon the short cycle rusts of Porto Rico, leading to the detection of 5 aecidioid forms previously placed under the form genus *Aecidium*, and of one uredinoid form quite unlike anything heretofore known.

KUNKEL followed up his discovery with supplementary studies, which he has embodied in a paper[4] dealing with the facts, so far as known, pertaining to the blackberry orange rust and of their probable bearing upon questions of relationship and evolution. He has concluded that there are in the United States two independent but in part similar rusts on *Rubus*, one a long cycle form, which he identifies with the *Gymnoconia interstitialis* of Europe, and the other a short cycle form, for which he uses the name *Caeoma nitens*, first given by SCHWEINITZ to a collection made in North Carolina.

No clear morphological characters were found by which to distinguish the short cycle form from the aecia of the long cycle form, although in germination the two behave quite unlike. It is assumed by KUNKEL that whatever the origin or degree of relationship of these two forms, they are to be considered and treated as distinct, a view in which the writer fully concurs.

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[1] KUNKEL, L. O., The production of a promycelium by the aecidiospores of *Caeoma nitens*. Bull. Torr. Bot. Club 40:361. 1913; see also Amer. Jour. Bot. 1:37. 1914.

[2] FROMME, F. D. and ARTHUR, J. C., A new North American *Endophyllum*. Bull. Torr. Bot. Club 42:55. 1915.

[3] OLIVE, E. W. and WHETZEL, H. H., *Endophyllum*-like rusts of Porto Rico. Amer. Jour. Bot. 4:44. 1917.

[4] KUNKEL, L. O., Further studies of the orange rusts of *Rubus* in the United States. Bull. Torr. Bot. Club 43:559. 1916.

A considerable difference in the distribution of the two forms is evident from KUNKEL'S studies, the long cycle form being more common northward and the short cycle form more common southward. So far the latter is not known in the Old World. Moreover, it is the short cycle form that appears to possess the chief economic importance in America by attacking cultivated varieties of *Rubus*, especially blackberries.

From these considerations it is evident that the two forms as a matter of convenience should be designated by different names, whatever views may be held as to their relationship. Since the appearance of KUNKEL'S first paper, appeals have been made to the writer a number of times for the correct application of the several names which have been in use. To meet an evident need, therefore, I have concluded to present the following arrangement of nomenclature and distribution, based upon such facts and material as are at hand.

The generic name *Gymnoconia* was founded by LAGERHEIM[5] in 1894 to more clearly recognize taxonomically the culture work of TRANZSCHEL[6] at Petrograd, Russia, performed during the summer of 1892, by which he genetically connected the caeomoid aecia of *Rubus saxatilis* with the puccinioid telia (*Puccinia Peckiana* Howe) on the same host. The same connection was made two years later by CLINTON[7] at Urbana, Illinois, using "*Rubus villosus*," the native blackberry of the region, being without doubt what is now called *R. nigrobaccus*. The genus *Gymnoconia*, therefore, represents the long cycle form, for which *interstitialis* is the oldest specific name. This was given to the aecia on *Rubus arcticus* from Kamchatka in 1820 by SCHLECHTENDAHL.[8] There can be no doubt, therefore, regarding the correct name for the long cycle form, unless exception be taken to the use of a specific name founded on the aecia, in which case the designation would become *G. Peckiana* (Howe) Trotter.

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[5] LAGERHEIM, G., Tromsö Mus. Aarsh. **16**:140. 1894.

[6] TRANZSCHEL, W., Culturversuche mit *Caeoma interstitiale* Schlechtd. (*C. nitens* Schw.). Hedwigia **3**:257. 1893.

[7] CLINTON, G. P., Relationship of *Caeoma nitens* and *Puccinia Peckiana*. BOT. GAZ. **20**:116. 1895.

[8] SCHLECHTENDAHL, D. F. L., Horae Phys. Berol. 96. 1820.

The short cycle form was first named by SCHWEINITZ[9] in 1822, as *Aecidium nitens*, in a paper on the fungi of North Carolina, the host being reported as *Rubus strigosus*, but a recent study of the type collection shows it to be in all probability *R. Enslenii* Tratt. This region is far south of the known range of the long cycle form, which may be considered sufficient evidence that SCHWEINITZ had only the short cycle form in hand. The specific name has been variously combined, usually in an unfortunate way, but in no case with a distinctive generic name.

Many short cycle genera have now been established. Those which come nearest to the desired characters for the *Rubus* rust are the aecidioid genus *Endophyllum*, and the uredinoid genus *Botryorhiza*. What is now needed is a caeomoid genus, for which no name exists. If any one feels reluctance in placing the telia of a short cycle form in a different genus from the aecia of a long cycle form from which they cannot be distinguished morphologically, let him reflect that he does not hesitate to call the common salt-grass rust *Uromyces Peckianus* Farl., when it has numerous mesospores, and *Puccinia subnitens* Diet., when the mesospores are few, a closer relationship than in the blackberry rusts. Other such accepted anomalies, in the application of the genera *Uromyces* and *Puccinia*, could be cited. After all, we are not near enough to a nomenclature of the rusts along well considered genetic lines to debar us from using such names as enable one to form the clearest concepts and to convey thoughts in the least ambiguous manner. To meet these requirements short cycle forms require separate generic designation from long cycle forms.

In proposing a generic name for the short cycle orange rust of blackberries and raspberries, I take the opportunity to recognize the distinguished service which Dr. LOUIS OTTO KUNKEL has rendered to uredinology, not alone by the discovery of the true nature of this rust through the use of free surface germination of the spores, but also by his subsequent studies and their clear and inspiring presentation.

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[9] SCHWEINITZ, L. D., Schrift. Nat. Gesell. Leipzig 1:69. 1822.

Kunkelia, gen. nov.

Cycle of development includes subcuticular pycnia and subepidermal telia.

Pycnia conical or columnar, the hymenium applanate; ostiolar filaments wanting.

Telia caeomoid, erumpent, applanate, more or less indefinite in outline, without peridium or paraphyses. Teliospores catenulate, globoid or some elongated, 1-celled; wall colorless or pale, verrucose.

Kunkelia nitens (Schwein.), comb. nov.—*Aecidium nitens* Schwein. Schrift. Nat. Gesell. Leipzig **1**:69. 1822 (type on *Rubus* "*strigosus*," error for *R. Enslenii*, Salem, N.C.); *Caeoma luminatum* Link in Willd. Sp. Pl. **6**^{2}:61. 1825 (founded on *A. nitens* Schwein.); *Caeoma* (*Aecidium*) *luminatum* Schwein. Trans. Amer. Phil. Soc. n. ser. **4**:293. 1832 (founded on *A. nitens* Schwein.).

VIII. IDAEI[10] (raspberry)

21. R. OCCIDENTALIS L. (*R. idaeus americanus* Torr.), black raspberry.—NEBRASKA: Peru, May 24, 1900, *John L. Sheldon;* INDIANA: Bourbon (cult.), May 22, 1889, *J. H. Parks;* NORTH CAROLINA: Leicester, June 12, 1909, *B. B. Higgins* (Barth. Fungi Columb. 2937); NEW YORK: Hempstead, Long Island, May 13, 1916, *Percy Wilson* 237; Sparrow Bush, Orange County, May 29, 1916, *Percy Wilson* 255; SOUTH DAKOTA: Lake Oakwood, June 1890, *Miss Stelter.*

XV. URSINI (western dewberry)

71. R. VITIFOLIUS Cham. and Schlecht.—CALIFORNIA: Chico, April 11, 1903, *E. B. Copeland* 3936 (SYDOW, Ured. 1785); Glendora, Los Angeles County, April 10, 1909, *C. F. Baker* 5273; OREGON: La Grand, July 20, 1914, *C. C. Cate* (cult., loganberry).

74. R. MACROPETALUS Dougl.—BRITISH COLUMBIA: Agassiz, June 1913, *James R. Weir* 84.

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[10] The numbered divisions of the hosts and the numbers before the species are those employed by RYDBERG in his monograph of *Rubus* in N. Am. Flora **22**:428. 1913.

XVII. DISCOLORES (sand blackberry)

77. R. CUNEIFOLIUS Pursh.—NORTH CAROLINA: Raleigh, without date, *F. L. Stevens* 136; ALABAMA: Auburn, April 26, 1914, *Fred. A. Wolf;* FLORIDA: Lake City, April 13, 1900, *H. H. Hume* 16; Lake City, April 29, 1896, *P. H. Rolfs* 25, same without date 38.

XVIII. ARGUTI (high blackberry)

78. R. SATIVUS (Bailey) Brainerd.—INDIANA: Daleville (cult.), June 8, 1914, *Leslie V. Shoemaker.*

79. R. NIGROBACCUS Bailey (*R. villosus* Bigel. not Thunb., Ait., or Bailey, collections often labelled *R. allegheniensis*).—MARYLAND: Rosecroft, Prince George County, May 24, 1910, *E. Bartholomew* (Barth. Fungi Columb. 3238); NEW YORK: Arkville, Delaware County, May 30, 1915, *Percy Wilson* 69; Orient, Long Island, June 2, 1915, *Roy Latham* 625; Walden, Orange County, June 20, 1908, *M. E. Cummings;* OHIO: College Hill near Cincinnati, May 15, 1899, *W. H. Aiken* (SYDOW, Ured. 1389); KENTUCKY: Dayton, June 21, 1910, *E. Bartholomew* (Barth. Fungi Columb. 3327); INDIANA: Madison, May 6, 1910, *A. G. Johnson;* Wirt, May 7, 1910, *A. G. Johnson;* ILLINOIS: Pine Hills, Union County, April 24, 1882, *A. B. Seymour* (Rab.-Wint. Fungi Eur. 3220*a*); Anna (cult.), June 13, 1888, *F. S. Earle* (Seym. and Earle, Econ. Fungi 27); MISSOURI: Columbia, May 1886, *Tracy* and *Galloway*, May 25, 1911, *G. M. Reed* 795; Cedar Gap, Ozark Mountains, alt. 1675 ft., May 22–June 3, 1911, *O. E. Lansing, Jr.* 2968; KANSAS: Manhattan, May 23, 1889, *Miss May Varney* (Kellerm. and Sw. Kans. Fungi 31); Louisville, June 1912, *E. Bartholomew* (Barth. N. Am. Ured. 605), May 1912, *E. Bartholomew* (Barth. Fungi Columb. 4233); MINNESOTA: Minneapolis, June 17, 1914, *Bartholomew* and *Holway* (Barth. N. Am. Ured. 1113, Barth. Fungi Columb. 4629); IOWA: Charles City, May 30 and June 20, 1882, *J. C. Arthur;* Decorah, June 11, 1883, *E. W. D. Holway;* Decorah, June 2, 1886, *E. W. D. Holway* (Barth. N. Am. Ured. 211); Decorah, June 3, 1886, *E. W. D. Holway;* Fayette, May 3, 1908, *Guy West Wilson;* OREGON: Freewater (cult., northeastern section of state), June 27, 1913, *F. D. Bailey.*

81. R. ARGUTUS Link (*R. Andrewsianus* Blanch.).—NEW YORK: Hunter Island, New York City, June 14, 1912, *F. D. Fromme* 12, June 18, 1916, *Percy Wilson* 294; White Plains, June 7, 1914, *Percy Wilson;* Bedford Park, New York City, June 9, 1915, *Percy Wilson* 77; Cold Spring Harbor, Long Island, June 13, 1915, *Percy Wilson* 79.

84. R. FRONDOSUS Bigel.—NEW YORK: Sparrow Bush, Orange County, May 31, 1916, *Percy Wilson* 262.

89. R. CANADENSIS L. not A. Gray.—NEW YORK: Arkville, Delaware County, July 6, 1915, *Percy Wilson* 95.

XIX. PROCUMBENTES (dewberry)

99. R. ABORIGINUM Rydb.—TEXAS: Houston, March 6, 1914, *Arthur* and *Fromme* 6108.

102. R. PROCUMBENS Muhl. (*R. canadensis* A. Gray, not L., *R. subuniflorus* Rydb., *R. villosus* Ait.).—NEW YORK: Van Cortlandt Park, New York City, April 25, 1912, *F. D. Fromme* 29; White Plains, June 7, 1914, *Percy Wilson* 2; Williamsbridge, New York City, June 10, 1914, *Percy Wilson* 4; Pleasantville, Westchester County, May 14, 1915, *Percy Wilson* 63; Hunter Island, New York City, May 23, 1915, *Percy Wilson;* Mamaroneck, Westchester County, June 6, 1915, *Percy Wilson* 76; Yonkers, May 27, 1916, *Percy Wilson* 250; Sparrow Bush, Orange County, May 29, 1916, *Percy Wilson* 257; Ithaca, May 30, 1906, *Reddick* and *Frazer;* NEW JERSEY: West Englewood, Bergen County, June 19, 1915, *Percy Wilson* 83; PENNSYLVANIA: Lancaster, May 31, 1910, *E. Bartholomew* (Barth. Fungi Columb. 3239); MARYLAND: High Island, near Washington, May 1894, *P. A. Rydberg;* Cabin John Bridge, June 15, 1910, *Bartholomew* and *Swingle* (Barth. Fungi Columb. 3524); DISTRICT OF COLUMBIA: Takoma Park, May 1898, *C. L. Shear* 1568; MINNESOTA: Nichols, Aitkin County, June 1892, *E. P. Sheldon;* NEW HAMPSHIRE: Temple, June 20, 1888, *A. B.* and *A. C. Seymour* (Seym. and Earle Econ. Fungi 28); CONNECTICUT: Central Village, June 20, 1903, *John L. Sheldon;* NEW JERSEY: Newfield, June 1874, *J. B. Ellis* (Thüm. Myc. Univ. 446); Newfield, June 1893, *J. B. Ellis* (Ellis and Ev. Fungi Columb. 57); DELA-

WARE: Newark, May 15, 1907, *H. S. Jackson* 1620; Newark, June 6, 1907, *Mel. T. Cook* 1661; INDIANA: Greencastle, May 1893, *L. M. Underwood* (Und. Ind. Flora 19); Lafayette, May 21, 1899, *Wm. Stuart;* Brookville, May 8, 1915, *C. A. Ludwig* (Barth. N. Am. Ured. 1411; Barth. Fungi Columb. 4926).

103. R. ENSLENII Tratt.—SOUTH CAROLINA: without locality or date (*Ravenel*, Fungi Car. 1:91); GEORGIA: Darien, without date (*Ravenel*, Fungi Am. 276); NORTH CAROLINA: Salem, without date, *L. D. Schweinitz.*

(?) RUBUS sp. (mostly cultivated blackberry).—MARYLAND: Beltville, May 24, 1916, *H. S. Coe;* MISSOURI: Columbia, May 7, 1905, *H. S. Reed;* OKLAHOMA: Stillwater (cult.), May 14, 1915, *C. D. Learn.*

XX. HISPIDI (running swamp dewberry)

108. R. HISPIDUS L.—NEW YORK: Hempstead, Long Island, May 13, 1916, *Percy Wilson* 234.

XXI. TRIVIALES (southern dewberry)

109. R. LUCIDUS Rydb. (reported in N. Am. Flora 7:181 under *R. trivialis*).—SOUTH CAROLINA: Aiken, March 15, 1909, *Arthur* and *Kern;* FLORIDA: Lake City, March 30, 1895, and February 17, 1906, *P. H. Rolfs;* St. Augustine, March 27, 1903, *E. W. D. Holway* (Barth. N. Am. Ured. 507).

110. R. TRIVIALIS Michx.—FLORIDA: Lake City, February 1896, *P. H. Rolfs* 23; LOUISIANA: New Orleans, February 24, 1913, *E. Bethel.*

111. R. CARPINIFOLIUS Rydb. (reported in N. Am. Flora 7:181 under *R. trivialis*); TEXAS: Austin, February 27, 1901, *W. H. Long* (Barth. Fungi Columb. 1622), March 14, 1901, *W. H. Long* (Barth. N. Am. Ured. 1504), March 16, 1901, *W. H. Long;* Huntsville, without date, *Carl Hartmann*, communicated F. D. HEALD.

DISTRIBUTION: Central Florida to southern Texas northward to Baltimore, Maryland, and central Illinois, still farther north through the prairie region west of the Mississippi River nearly to the Canadian boundary, and along the Atlantic coast within about

100 miles of the sea as far as New York, then nearer to the sea as far as the coast of New Hampshire, also along the Pacific coast within 100 miles of the sea from southern California to southeastern extension of Alaska, the distance from the sea narrowing northward.

Kunkelia Rosae-gymnocarpae (Dietel), comb. nov.—*Caeoma Rosae-gymnocarpae* Dietel, Hedwigia **44**:334. 1905; *Gymnoconia Rosae-gymnocarpae* Arth. N. Am. Flora **7**:181. 1912.

ROSA GYMNOCARPA Nutt.—CALIFORNIA: Santa Cruz, without date, *C. L. Anderson*, communicated W. G. FARLOW; Modoc and Lassen Counties, "killing wild rosebushes," without date, communicated W. G. FARLOW; Jackson, Amador County, without date, *Geo. Hansen* 1012; Ione, Amador County, March 25, 1896, *Geo. Hansen* 2087.

DISTRIBUTION: From central California to northeastern California.

GYMNOCONIA INTERSTITIALIS (Schlecht.) Lagerh. Tromsö Mus. Aarsh. **16**:140. 1894.—*Caeoma* (*Uredo*) *interstitiale* Schlecht. Horae Phys. Berol. 96. 1820 (type on *Rubus arcticus* L., Kamchatka); *Uredo interstitialis* Schlecht. Horae Phys. Berol. 96. 1820 (variant of the preceding name); *Puccinia Peckiana* Howe, Peck, Ann. Rep. N.Y. State Mus. **23**:57. 1872 (type on *Rubus occidentalis* L., New Baltimore, New York); *Puccinia tripustulata* Peck, Ann. Rep. N.Y. State Mus. **24**:91. 1872 (type on *Rubus "villosus," Greig*, New York); *Uredo luminatum* Thüm. Bull. Soc. Imp. Nat. Moscou **55**:85. 1880 (type on *Rubus saxatilis* L., Minussinsk, Siberia); *Caeoma nitens* Burrill, Bull. Ill. Lab. Nat. Hist. **2**:220. 1885 (type on *Rubus occidentalis* L., et al., McLean County, Illinois); *Uredo* (*Caeoma*) *nitens* DeToni in Sacc. Syll. Fung. **7**:866. 1888 (type on *Rubus saxatilis* L., et al., Asiatic Siberia); *Puccinia interstitialis* Tranz. Hedwigia **32**:259. 1893 (founded on *Caeoma interstitiale* Schlecht. and *Puccinia Peckiana* Howe, supported by cultures on *Rubus saxatilis*, Petrograd, Russia); *Dicaeoma tripustulata* Kuntze, Rev. Gen. **3**^{3}:467. 1898 (founded on *Puccinia tripustulata* Peck); *Gymnoconia Peckiana* Trotter, Fl. Ital. Crypt. **1**^{12}:338. 1910 (founded on *Puccinia Peckiana* Howe and *Caeoma interstitialis* Schlecht., with *Rubus saxatilis* cited) *Gymnoconia Peckiana* Kleb. Krypt. Fl. Brand. 5*a*:665. 1913.

A. Hosts for aecia

IV. ARCTICI (northern dwarf raspberry)

4. R. STELLATUS Smith.—ALASKA: Unalaschka (Bernhardi herbarium at Mo. Bot. Garden).

5. R. ACAULIS Michx. (distributed as *R. arcticus*).—YUKON: White Horse Rapids, June 16, 1899, *J. B. Tarleton*.

VIII. IDAEI (raspberry)

21. R. OCCIDENTALIS L. (*R. idaeus americanus* Torr.), black raspberry.—VERMONT: Charlotte, June 12, 1880, *C. G. Pringle* 1128; Burlington, June 11, 1891, *Collins* F1363; ONTARIO: London, May 20, 1911, *J. Dearness* 1838 *c;* Glenora, June 7, 1912, *J. Dearness* (Barth. N. Am. Ured. 1208); MICHIGAN: Ann Arbor, June 6, 1916, *C. A. Ludwig* 131; OHIO: Olena, Huron County, June 2, 1902, *O. E. Jennings* (Kellerm. Ohio Fungi 67); MASSACHUSETTS: Granville, June 1883, *A. B. Seymour;* CONNECTICUT: Central Village, June 28, 1903, *John L. Sheldon;* NEW YORK: Onondaga Valley, June 1885, *L. M. Underwood;* Ithaca, June 27, 1907, *Whetzel* and *Barrus;* WEST VIRGINIA: Seneca,. May 30, 1904, *John L. Sheldon* 25; Morgantown (cult.), June 8, 1904, *John L. Sheldon* 502.

32. R. STRIGOSUS Michx. (*R. idaeus aculeatissimus* Rob. and Fern.), red raspberry.—VERMONT: Burlington, June 10, 1891, *Collins* F1362; Burlington, June 14, 1893, *L. R. Jones;* Burlington, June 10, 1898, *W. A. Orton* F1807; NEW BRUNSWICK: Salisbury, July 2, 1905, *C. L. Moore* 9; NEW YORK: Lyndonville, June 1, 1886, *C. E. Fairman;* MASSACHUSETTS: Newton, 1880, *W. G. Farlow* (Ellis, N. Am. Fungi 277, 278, Roumeguère, Fungi Gall. 874).

XVIII. ARGUTI (high blackberry)

79. R. NIGROBACCUS Bailey.—VERMONT: Without locality, 1893, *A. J. Grout;* NEW YORK: Alcove, May and June 1892, *C. L.*

Shear (Shear, N.Y. Fungi 133); Taberg, Oneida County, June 1887, *L. M. Underwood;* Trumansburg (cult.), June 4, 1904, *H. H. Whetzel;* MAINE: Isle au Haut, May 31, 1912, *Arthur* and *Orton* 123; OHIO: Amanda, without date, *W. A. Kellerman* (Rab.-Wint. Fungi Eur. 3225 *b*); Columbus, May 5, 1901, *W. A. Kellerman* 3853 (Kellerm. Ohio Fungi 20); Columbus, June 2, 1901, *W. A. Kellerman* 3854 (Kellerm. Ohio Fungi 19); Johnston, June 18, 1910, *E. Bartholomew* (Barth. Fungi Columb. 3630); MICHIGAN: Portage Lake, Dexter, June 22, 1913, *E. B. Mains* 38.16; WISCONSIN: without locality, 1883, *L. H. Pammel;* Racine, June 26, 1887, *J. J. Davis;* Madison, May 24, 1911, *E. T. Bartholomew* (Barth. N. Am. Ured. 1007, Barth. Fungi Columb. 3911); ILLINOIS: Oregon, June 16, 1885, *M. B. Waite;* Peoria, June 15, 1894, *F. E. McDonald;* INDIANA: Greencastle, May 1878, *Mel. T. Cook;* Lafayette, June 7, 1894, *Miss K. E. Golden;* Greencastle, July 5, 1895, *Guy West Wilson;* Lafayette, May 18, 1896, *Miss Lillian Snyder;* Greencastle, May 27, 1897, *Mel. T. Cook;* Lafayette, April 28, 1898, May 19, 1899, *J. C. Arthur;* Lafayette, May 30, 1909, *Miss Evelyn Allison;* South Bend, June, 1909, *Miss Clara Cunningham;* Lafayette, June 6, 1911, *E. Trager;* Lafayette, June 21, 1912, *C. A. Ludwig;* Indianapolis, June 4, 1912, *N. K. Thompson;* VIRGINIA: Rosalyn, May 28, 1910, *C. L. Shear* (Barth. N. Am. Ured. 106).

81. R. ARGUTUS Link (*R. Andrewsianus* Blanch.).—MASSACHUSETTS: Barre, June 3, 1899, *Harold B. Smith.*

91. R. RANDII (Bailey) Rydb.—NOVA SCOTIA: Pictou, August 1, 1908, *W. P. Fraser* (accompanied with telia).

(?) RUBUS sp. (mostly cultivated blackberry).—ONTARIO: Muskoka, June 24, 1890, *Macoun;* Prince Edward Island: May 7, 1883, *Macoun;* VERMONT: Colchester, June 28, 1894, *L. R. Jones;* MAINE: Orono, June 1898, *P. L. Ricker;* NEW YORK: Onondaga Valley, June 1889 (Und. and Cook, Cent. Ill. Fungi 51); PENNSYLVANIA: Charter Oak, May 1, 1916; *J. C. Arthur;* WEST VIRGINIA: Morgantown, May 7, 1904, *John L. Sheldon* 24; INDIANA: Lafayette (cult.), May, 1901, *H. B. Dorner;* Broad Ripple (cult.), May 25, 1901, *Mrs. L. D. Dickey.*

B. Hosts for telia

V. SAXATILES (dwarf raspberry)

9. R. PUBESCENS Raf. (*R. triflorus* Rich., *R. canadensis* Torr. not L.).—NEW HAMPSHIRE: Albany, August 1908, *W. G. Farlow;* WISCONSIN: Oconto County, July 21, 1909, *J. J. Davis.*

VIII. IDAEI (raspberry)

21. R. OCCIDENTALIS L. (*R. idaeus americanus* Torr.), black raspberry.—VERMONT: Burlington, August 20, 1890, *L. R. Jones* F1299; NEW YORK: Ithaca, September 30, 1912, *B. B. Higgins* (Barth. Fungi Columb. 4020); Ithaca, August 28, 1902, *H. H. Whetzel;* Poughkeepsie, August 1871, *W. R. Gerard* 853; Enfield near Ithaca, September 15, 1902, *J. M. Van Hook;* Glen near Ithaca, August 12, 1904, *H. S. Jackson;* Junius, September 13, 1904, *H. S. Jackson;* MASSACHUSETTS: Mt. Tom, August 20, 1883, *A. B. Seymour;* Newton, *W. G. Farlow* (Ellis, N. Am. Fungi 261); ILLINOIS: Urbana, September 7, 1886, *M. B. Waite* 47.

22. R. STRIGOSUS Michx., red raspberry.—NEW YORK: Junius, September 16, 1904, *H. S. Jackson.*

XVIII. ARGUTI (high blackberry)

79. R. NIGROBACCUS Bailey (*R. villosus* Bigel. not Thunb., Ait., or Bailey, collections often labelled *R. allegheniensis*).—VERMONT: Jamaica, September 12, 1890, *A. J. Grout* 426; NEW YORK: Alcove, August 1892, *C. L. Shear* (Shear, N.Y. Fungi 67); Alcove, August 1893, *C. L. Shear* (Ellis and Ev. Fungi Columb. 346); Ithaca, September 13, 1911, *B. B. Higgins* (Barth. Fungi Columb. 3631); Forest Home near Ithaca (cult.), July 22, 1906, *H. H. Whetzel;* MICHIGAN: Leland, August 23, 1913, *J. C. Arthur;* ILLINOIS: Urbana, July 29, 1884, *T. J. Burrill* (Seym. and Earle, Econ. Fungi 26); without locality, 1887, *T. J. Burrill* (Ellis and Ev. Fungi Columb. 653); Middlegrove, September 17, 1907, *E. Bartholomew* (Barth. Fungi Columb. 2568); INDIANA: Lafayette, October 19, 1895, *Wm. Stuart;* Brookville, September 9, 1916, *C. A. Ludwig* 180.

89. R. CANADENSIS L. not A. Gray (*R. Millspaughi* Britton).—VERMONT: Stratton, August 7, 1894, *A. J. Grout* F30 (reported in N. Am. Flora 7:181 under *R. vermontanus*); NEW YORK: sphagnum swamps at Junius, September 16, 1904, *Jackson* and *Whetzel;* Old Forge, August 25, 1913, *L. O. Kunkel;* Freeville, September 23, 1902, *C. H. Kauffman;* Malloryville, August 19, 1904, *H. S. Jackson;* Seventh Lake, Adirondack Mountains, August 18, 1909, *B. M. Duggar;* MAINE: Isle au Haut, September 10, 1899, *J. C. Arthur;* MICHIGAN: Neebish Isle, August 25, 1899, *E. T.* and *S. A. Harper;* WISCONSIN: Price County, September 17 and 22, 1911, *J. J. Davis;* WEST VIRGINIA: Cheat Bridge, August 18, 1906, *John L. Sheldon* 2433.

91. R. RANDII (Bailey) Rydb.—NOVA SCOTIA: Pictou, August 1, 1908, *W. P. Fraser* (accompanied with aecia).

DISTRIBUTION: From a southern boundary beginning in the vicinity of Boston, Massachusetts, diverging gradually to about 100 miles from the coast as far as central Maryland, then westward to central Illinois on the Mississippi River, and northward into Ontario and Quebec, especially along the Atlantic coast as far as Prince Edward Island, also on the Pacific coast from the vicinity of Mount St. Elias along the Aleutian Islands and the coast of Behring Sea into Asia. In the eastern hemisphere it occurs in northern Siberia and in northern Europe and the high mountains of central Europe.

In the foregoing lists of hosts and localities all the specimens now in the Arthur Herbarium have been entered. This has been done for three principal reasons. It will enable any person having one of these collections to know what disposition has been made of it in the present study, both as to fungus and host; it will serve to show in detail on what data the conclusions of this paper are founded; and, moreover, it is hoped that the long list of localities and hosts will lead to many germination tests. Such tests are very simple. The spores are dusted on the surface of water, and at intervals of 12–48 hours examined under the microscope to see if the germ tube be long and hyphoid, or short and septate with formation of basidiospores. The work will be enhanced in value if drawings are made or the germinating spores preserved dry between thin sheets of mica, and if a large specimen of the host be pressed for the purpose of specific determination.

The *Rubus* hosts of the lists were carefully examined by P. A. RYDBERG of the New York Botanical Garden, on January 30, 1917, and the names used are in accordance with his judgment. Of course, no person can name species of *Rubus* with much confidence from leaves alone, as in many collections of the rusts, but the list presents the nearest approach to accuracy at present possible. The species have been listed under the divisions of the genus, and with the serial numbers of the species as given by RYDBERG in his monograph of the genus *Rubus* in the *North American Flora*, better to show the relation of the hosts and their possible susceptibility to the rusts. Whenever the specimen is said to come from a cultivated plant, it has been so indicated.

In only one instance have aecia and telia been found on the same plants. Only from Van Cortlandt Park and a few other places in the vicinity of New York City, and from Glen, New Hampshire, have the germination of the spores been satisfactorily observed. In all other cases the aecia of the *Gymnoconia* and the caeomoid telia of the *Kunkelia* have been separated largely upon arbitrary grounds. The geographical factor in connection with known localities for puccinioid telia has been given much weight, while various other collateral items of information have been utilized. In arriving at a conclusion I have had the valuable assistance of Dr. KUNKEL, who kindly went over all the material with me. One reason for making this assortment in detail is the hope of enlisting the interest of any botanist who may have the opportunity of testing the spore germination in moist air from the localities and hosts named, thus aiding in gradually verifying and rectifying the list.

All present evidence goes to show that the long cycle form on *Rubus* is essentially a northern species, while the short cycle form is essentially southern. Fig. 1 shows the present view regarding geographical distribution. The chart is based entirely upon the data given in the preceding lists of hosts, the southern limit of the *Gymnoconia* being in large part that indicated by the collections of telia. It will be seen that the two forms overlap along an uncertain line running from eastern Massachusetts not far from the Atlantic coast to northern Delaware, then through northern Virginia and West Virginia, south-central Ohio and Indiana to central Illinois, thence northward along the Mississippi River. On the Pacific coast the region within 100 miles or less from the sea is occupied apparently by the short cycle form from Mount St. Elias to southern California, and by the long cycle form from Mount St. Elias northward and westward into Asia. No collections are known from the arid region of the plains and Rocky Mountains. To what extent the two forms overlap must be left to the future for decision. There seems to be no doubt, however, that the northernmost area of the continent is occupied by the long cycle form, and the southernmost area by the short cycle form, which appears to be

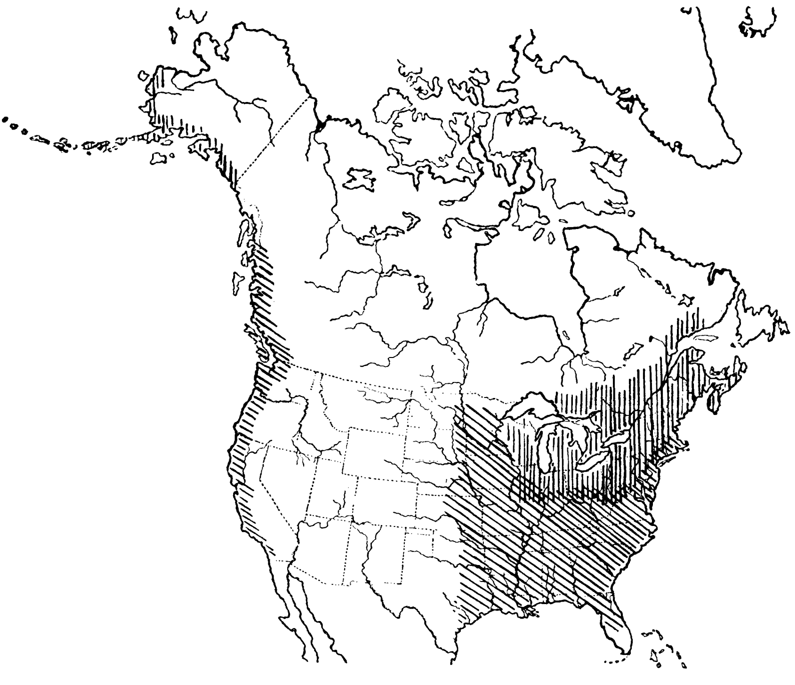

FIG. 1.—Distribution in North America of *Gymnoconia interstitialis* (vertical lines) and *Kunkelia nitens* (oblique lines).

in accord with tendencies recently pointed out by the writer[11] in studying the rusts of tropical America.

Not much can be said regarding susceptibility of hosts. So far as now known, geographical range is more important in determining the susceptibility of the host than the species of *Rubus*. There appears to be some warrant, however, in thinking that the short cycle form is the one "so destructive to our cultivated blackberries and raspberries in this country," as suggested by KUNKEL.[12]

Probably no other species known are so well adapted for the study of the connection between closely related long and short cycle forms, and their possible evolutionary status.

The rose *Caeoma* of northern California is transferred to the genus *Kunkelia* with some confidence in advance of knowledge regarding the spore germination, partly because no puccinioid form has been found associated with it, and partly because of its general similarity to *Kunkelia nitens*.

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[11] ARTHUR, J. C., Rusts of the West Indies. Torreya **17**:26. 1917.

[12] KUNKEL, L. O., Bull. Torr. Bot. Club **43**:569. 1916.